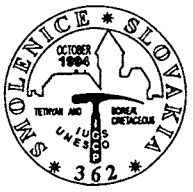
GEOLOGICA CARPATHICA, 46, 5, BRATISLAVA, OCTOBER 1995
297 – 302

THE STRATIGRAPHICAL CORRELATION OF THE CAMPANIAN LOW- AND HIGH-LATITUDE CALCAREOUS NANNOFOSSILS IN SOUTHERN MORAVIA (WESTERN CARPATHIANS)



LILIAN ŠVÁBENICKÁ

Czech Geological Survey, Klárov 131/3, 118 21 Praha 1, Czech Republic

(Manuscript received February 16, 1995; accepted in revised form June 14, 1995)

Abstract: The mixing of boreal and Mediterranean/Tethyan calcareous nannofossils was observed in the Campanian sediments of the Ždánice Unit in Southern Moravia. The first occurrence of these high- and low-latitude species, and their correlation with standard and boreal nannoplankton zonations have been compared. The presence of *Petrarhabdus copulatus* probably indicates an influence on this depositional area by the Indian and South Atlantic oceans.

Key words: Western Carpathians, Campanian, nannofossils, biostratigraphy, bioprovinces.

Introduction

The mixing of low- and high-latitude species in the nannoplankton assemblages was observed by the author during her stratigraphical study of the Upper Cretaceous sediments in Southern Moravia (Outer Western Carpathians), especially in the Campanian. This fact offered an uncommon opportunity to compare the occurrences of these ecologically-restricted nannofloras, whose distribution in the water mass was limited by, among other factors, paleotemperatures.

The correlation of the standard nannoplankton zonation with the boreal zonation is rather problematic in the Campanian. Common occurrences of both low- and high-latitude nannofossils are rare and in the literature rarely mentioned.

Previous studies

The Cretaceous standard nannoplankton zonation was introduced by Sissingh (1977) and supplemented by Perch-Nielsen's nannofossil event observations (1985). In the Campanian, it is established mostly on the presence of low- and mid-latitude species, such as *Ceratolithoides aculeus, Quadrum sissinghii* and *Q. trifidum*, which are rare or absent in the cool-temperate realms.

Crux (1982) elaborated the Upper Cretaceous biozonation scheme in Southern England and suggested the Prediscosphaera stoveri Zone for the "Upper" Campanian. He noted that the appearance level of *Prediscosphaera stoveri* is uncertain in relation to Sissingh's (1977) zonation, but placed it close to the Zone CC19/20 boundary. Perch-Nielsen (1985) located the first occurrence of *P. stoveri* at the middle of the Quadrum nitidum Zone. Mortimer (1987) suggested a nannofossil zonal scheme for the Southern Norwegian and Danish North Sea Area spanning the Cenomanian to the Maastrichtian. This zonation is proposed as a workable scheme for the oil industry and is based on the first or last downhole nannofossil occurrences. Mortimer (item) indicated the *Prediscosphaera stoveri* appearance approximately within the period when *Dodekapodorhabdus noeliae, Prediscosphaera arkhangelskyi* and *Reinhardtites levis* occur for the first time.

Burnett (1990) worked out an alternative zonation for the boreal region that bridges the gap between Zones CC18 and CC22b in the Sissingh's scheme, i.e. between the first occurrence of *Broinsonia parca* and the first occurrence of *Reinhardtites levis*. For this interval Burnett assigned three partial range zones: Broinsonia parca, Staurolithites mielnicensis and Monomarginatus quaternarius Zone. The evolutionary appearance of *P. stoveri* is mentioned as uncertain in her opinion, around the first occurrence of *Reinhardtites levis*.

Material

In Southern Moravia, the Upper Cretaceous sediments occur in the Ždánice Unit and the Zdounky Unit which are grouped under the term Outer Group of nappes (Fig. 1). They were deposited east of their present location in a normal-salinity environment on the Jurassic basement, which is tectonically amalgamated into the structure of the Flysch Belt of the Western Carpathians. The Campanian sediments mostly consist of greenish-grey marls and clays, with a minimum admixture of sand. Abel (1899) reported sediments of the Ždánice Unit and the Waschberg Zone in Lower Austria as "mucronata marls" due to the rare finds of *Belemnitella mucronata* (Schloth.). This submitted study deals with the Ždánice Unit only.

From the paleogeographical point of view, the Ždánice Unit depositional area was situated on the southeastern passive margin of the European Platform. Geologically, the Ždánice Unit belongs to the Outer Western Carpathians that should be included among the warm-temperate realm (Mediterranean/Tethyan bioprovince). In the northwest, autochthonous Cretaceous epicontinental sediments of the cool-temperate realm (boreal bioprovince) such as the Bohemian Cretaceous Basin or the Opole Trough occur.

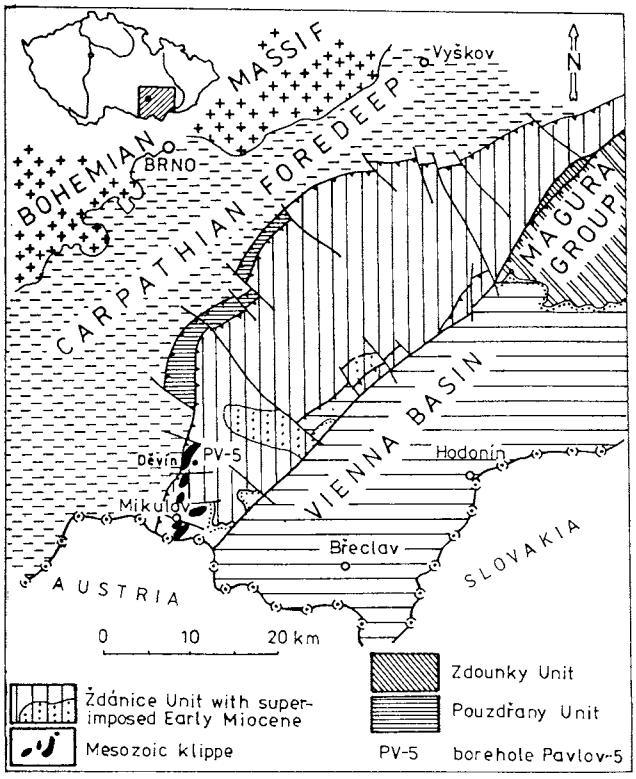


Fig. 1. Tectonic sketch-map of the Western Carpathians in the southern Moravia region. The Ždánice Unit, Pouzdřany Unit and Zdounky Unit are grouped under the term the Outer Group of the nappes.

Campanian nannofossils were studied both from the borehole Pavlov-5 (Švábenická 1992) and outcrops Mikulov and Děvín (Švábenická et al. 1991; Stráník et al. in press). The sediments contained predominantly rich and well-preserved assemblages with a minimum of reworking. Besides nannofossils, foraminifers, radiolarians and fish teeth were also found there.

Methods

Samples were prepared by decantation. Canada balsam was used as the mounting medium for the smear slides. The investigations were carried out using a Nikon light microscope.

Results

The following succession of the first occurrences of the stratigraphically important nannofossils was observed in the studied material: *Aspidolithus parcus - Staurolithites mielnicensis - Dodekapodorhabdus noeliae - Prediscosphaera stoveri - Monomarginatus quaternarius - Ceratolithoides aculeus - Quadrum sissinghii - Petrarhabdus copulatus - Ceratolithoides arcuatus* (Fig. 2; Pl. I and II).

The first occurrence of *Prediscosphaera stoveri* seems to be a quite important datum for the studied sediments. According to the observations, its first occurrence already preceded the appearance of the high-latitude species *Monomarginatus quaternarius* and low-latitude species *Ceratolithoides aculeus* during the late Early Campanian. Besides, in the same time other changes are observed within the nannofossil assemblage. *Dodekapodorhabdus noeliae, Biscutum coronum* and *Arkhangelskiella cymbiformis* occur for the first time near this datum. Near this level, *Micula decussata* prominently increases in number and the abundance ratio between *Micula decussata* and *Watznaueria barnesae* changes. In addition, the abundance of *Kamptnerius magnificus* decreases and specimens of genus *Lucianorhabdus* become very rare (Fig. 2).

The youngest Cretaceous sediments of the Ždánice Unit are of the early Late Campanian age, Zone CC21b with sporadic *Ceratolithoides arcuatus* and, among others, *Biscutum dissimilis, Petrarhabdus copulatus, Reinhardtites levis, Eiffellithus eximius, Stoverius biarcus* and *Aspidolithus parcus*.

Discussion

The first occurrence of *Reinhardtites levis* is not clear from the material studied. This species appears approximately at the level of the lowermost occurrence of *Prediscosphaera stoveri*, in agreement with the Burnett's (1990) statement. The precise differentiation between *R. anthophorus* and *R. levis* is sometimes difficult in the light microscope, especially when coccoliths are overgrown. This problem is mentioned by Burnett (item) and also by Wagreich (1992a) in his study of the Austrian Gosau section. Two important questions arise from the above given facts: 1 - Does *Reinhardtites levis* already appear during the late Early Campanian, before the first occurrence of *Ceratolithoides aculeus*? 2 - Is this species really a suitable marker since its identification is rather problematic using a light microscope?

The presence of *Petrarhabdus copulatus* in the Outer Western Carpathians is interesting from the paleogeographical point of view. This nannolith was described by Deflandre (1959) from the Maastrichtian sediments of France but it is mostly known from the southern hemisphere in the Indian Ocean and Atlantic Ocean. *P. copulatus* is common in the samples of approximate paleolatitudes 30° and 40° S but absent from the samples of the same age from the more poleward localities (Wind 1975). Up to now its rare appearance in the northern hemisphere has been recorded by Varol (1992) in Turkey and by Burnett (personal communication) in the Northeast Atlantic Ocean.

Plate I: Figs. 1, 2. *Eiffellithus eximius* (Stover) Perch-Nielsen; borehole Pavlov-5, 57.80 m. **Figs. 3, 4.** *Dodekapodorhabdus noeliae* Perch-Nielsen; Mikulov 619. **Fig. 5.** *Marthasterites furcatus* (Deflandre) Deflandre; Děvín, sample A. **Fig. 6.** *Lithastrinus grillii* Stradner; borehole Pavlov-5, 62.10 m. **Figs. 7, 8.** *Monomarginatus quaternarius* Wind & Wise; Děvín, sample L. **Figs. 9, 10.** *Staurolithites* sp.; Mikulov 619. **Fig. 11.** *Staurolithites mielnicensis* (Górka) Perch-Nielsen; Děvín, sample I. **Fig. 12.** *Calculites obscurus* (Deflandre) Prins & Sissingh; Mikulov 619. **Figs. 13, 14.** *Ceratolithoides aculeus* (Stradner) Prins & Sissingh; Mikulov 619. **Figs. 15, 16.** *Ceratolithoides aculeus* (Stradner) Prins & Sissingh; Děvín, sample K. **Fig. 17.** *Ceratolithoides arcuatus* Prins & Sissingh; Děvín, sample M. **Fig. 18.** *Tranolithus phacelosus* Stover; Děvín, sample K. **Figs. 19–22.** *Quadrum sissinghii* Perch-Nielsen; Děvín, sample L. **Figs. 23, 24.** *Petrarhabdus copulatus* (Deflandre) Wind & Wise; Děvín, sample M. **Figs. 25, 26.** *Aspidolithus parcus constrictus* (Hattner) Perch-Nielsen; Děvín, sample A. **Figs. 27, 28.** *Arkhangelskiella cymbiformis* Vekshina; Děvín, sample L. **Figs. 29, 30.** *Arkhangelskiella cymbiformis* Vekshina; Mikulov 619. **Figs. 31, 32.** *Biscutum constans* (Górka) Black; Mikulov 619. **Figs. 33, 34.** *Biscutum magnum* Wind & Wise; Mikulov 619. **Figs. 35, 36.** *Biscutum coronum* Wind & Wise; Děvín, sample I. Magnification 2,000×, photomicrographs by author.

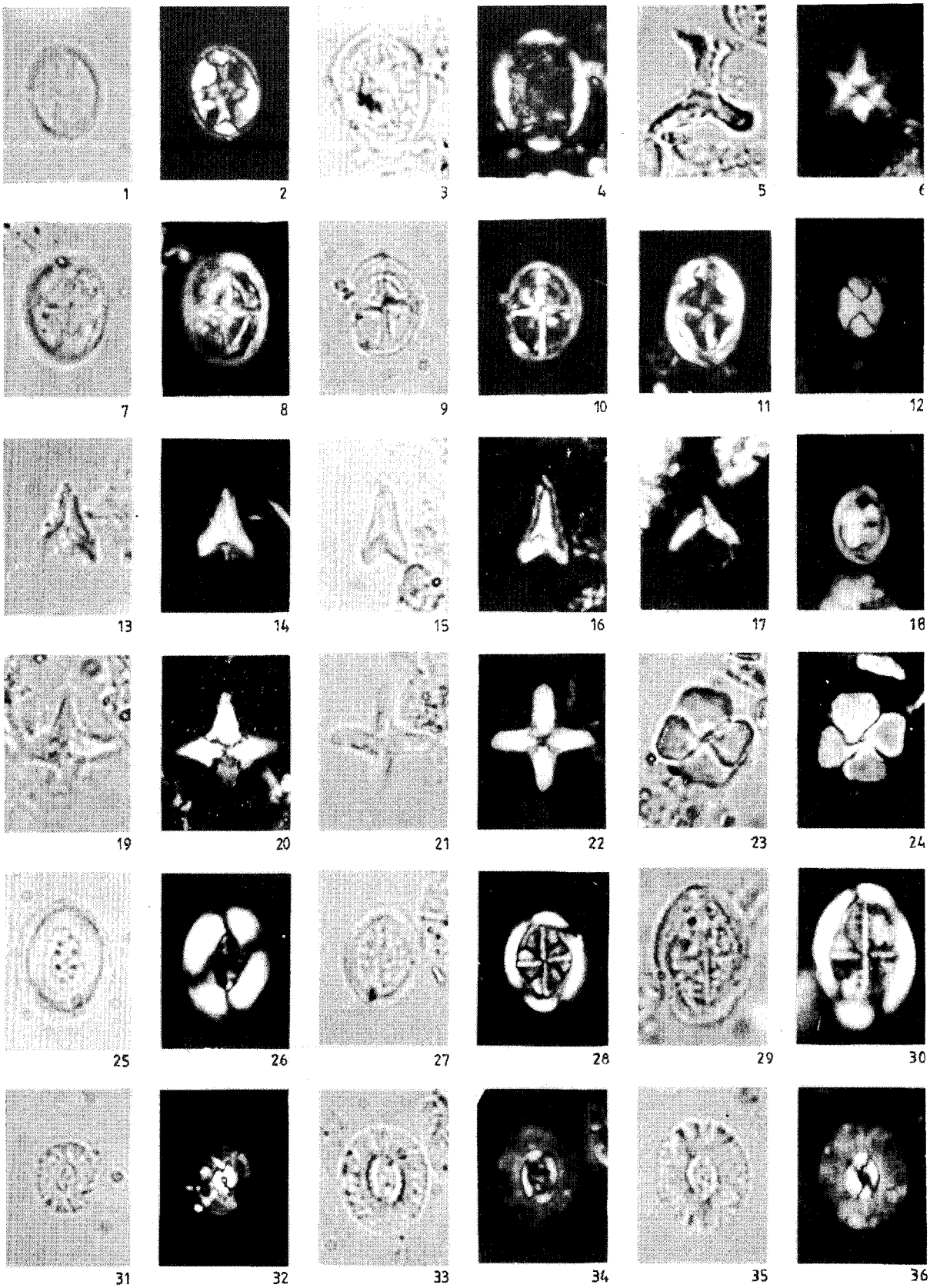
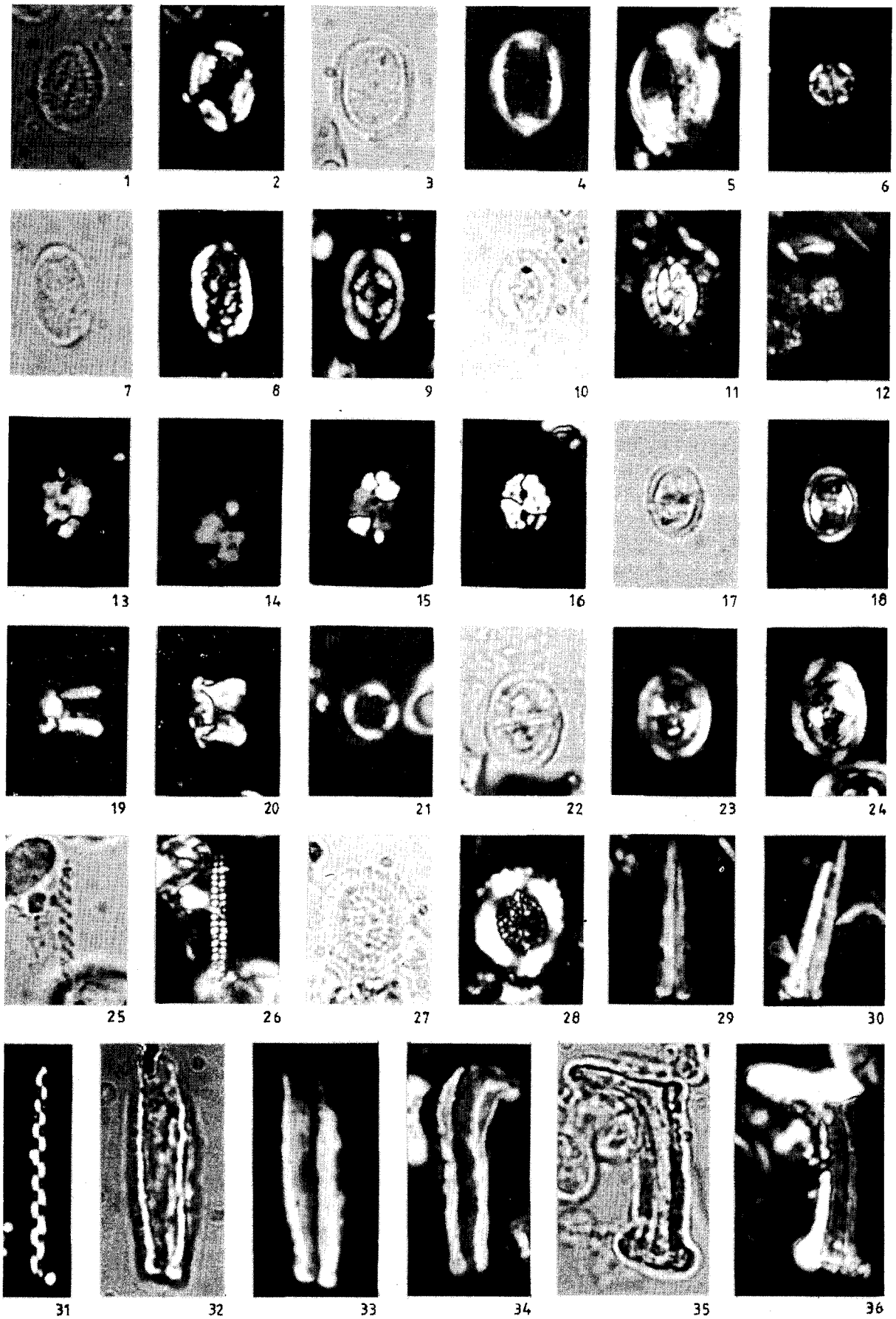

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

PLATE II


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

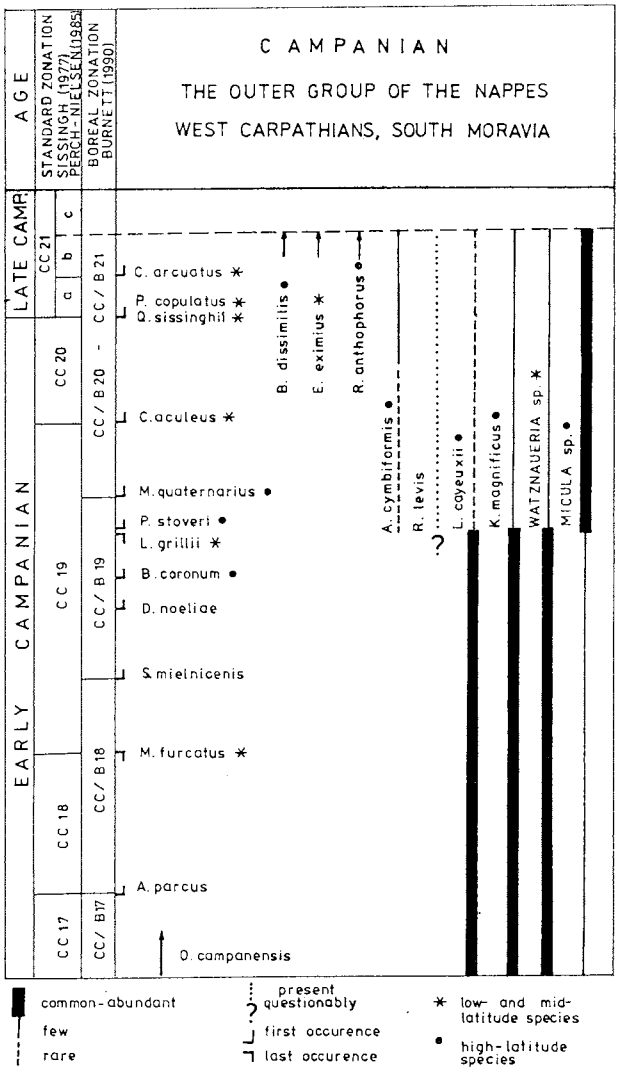


Fig. 2. Distribution of the stratigraphically significant calcareous nannofossils in the Campanian sediments of the Ždánice Unit (Outer Western Carpathians) and its correlation with the standard nannofossil zones of Sissingh (1977) and Perch-Nielsen (1985) and boreal zonation scheme (Burnett 1990). Data compiled by Wind (1979), Burnett (1990) and Merlo (1994).

Conclusion

The stratigraphical range of the Campanian sediments in the Ždánice Unit may be correlated within the interval of Zones CC17 - CC21b of the standard nannoplankton zonation (Sissingh 1977; Perch-Nielsen 1985) and simultaneously with Zones CC/B17 - CC/B21 of boreal nannoplankton zonation (Burnett 1990).

The mixing of boreal and Mediterranean/Tethyan species is evident, especially near the Early-Late Campanian boundary. In the late Early Campanian, the high-latitude species *Monomarginatus quaternarius, M. pectinatus, Prediscosphaera stoveri* and *Biscutum coronum* appear in association with the low-latitude *Ceratolithoides aculeus* that is the marker species of Zone CC20. The early Late Campanian is documented by the nominate species of Zone CC21 *Quadrum sissinghii* and, besides others, by the low-latitude nannofossils *Petrarhabdus copulatus* and *Ceratolithoides arcuatus* and the high-latitude species *Biscutum dissimilis*.

According to the finds of *Petrarhabdus copulatus*, influence from the Indian or South Atlantic oceans can be supposed for the depositional area of the Ždánice Unit (Outer Western Carpathians) during the early Late Campanian.

Appendix

Wagreich (1992b) in his review of low-latitude "Tethyan" calcareous nannoplankton assemblages stated that nannofossil bioprovincialism increased during the Late Cretaceous resulting in the coexistence of typical Tethyan/tropical, subtropical and high-latitude (boreal-austral) species. Especially Campanian-Maastrichtian nannofossil assemblages are strongly influenced by latitudinal trends and biogeographic boundaries.

This appendix lists calcareous nannofossils mentioned in this report, in the alphabetical order of Species epithets. Only remarks dealing with nannofloral competence to the bioprovinces are made where applicable. Wind (1979) introduced the most common species of the Falkland Plateau (high southern latitude/austral province).

Ceratolithoides aculeus (Stradner) Prins & Sissingh, low- and mid-latitude species (Perch-Nielsen 1985; Burnett 1990)

Reinhardtites anthophorus (Deflandre) Perch-Nielsen, high-latitude species (Wind 1979), more common in high northern latitudes (Perch-Nielsen 1985)

Ceratolithoides arcuatus Prins & Sissingh, absent in high northern latitudes (Perch-Nielsen 1985)

Prediscosphaera arkhangelskyi (Reinhardt) Perch-Nielsen

Watznaueria barnesae (Black) Perch-Nielsen, dominant low-latitude nannofloral component (Wind 1979)

Stoverius biarcus (Bukry) Perch-Nielsen

Orastrum campanensis (Čepek) Wind & Wise

Lucianorhabdus cayeuxii Deflandre, high-latitude species (Thierstein 1976; Wind 1979)

Petrarhabdus copulatus (Deflandre) Wind & Wise, common in approximate paleolatitudes 30° and 40° S but absent more poleward (Wind 1975)

Plate II: Figs. 1, 2. *Percivalia porosa* Bukry; Mikulov 619. **Figs. 3, 4.** ?*Cribrosphaerella* sp., ?*Psyktosphaera* sp.; borehole Pavlov-5, 15.80 m. **Fig. 5.** *Kamptnerius magnificus* Deflandre; Mikulov 619. **Fig. 6.** *Corollithion exiguum* Stradner; Mikulov 619. **Figs. 7, 8.** *Rhagodiscus* sp. cf. *R. eboracensis* Black; Mikulov 619. **Fig. 9.** *Rhagodiscus splendens* (Deflandre) Verbeek; Děvín, sample A. **Figs. 10, 11.** *Prediscosphaera arkhangelskyi* (Reinhardt) Perch-Nielsen; borehole Pavlov-5, 41.50 m. **Fig. 12.** *Prediscosphaera stoveri* (Perch-Nielsen) Shafik & Stradner; Děvín, sample L. **Figs. 13–15.** *Ottavianus giannus* Risatti; Mikulov 619, one specimen in crossed-nicols at 0°, 30°, 45°. **Fig. 16.** *Ottavianus giannus* Risatti; Mikulov 619. **Figs. 17, 18.** *Placozygus sigmoides* (Bramlette & Sullivan) Romein; Děvín, sample C. **Fig. 19.** ?*Stoverius* sp., ?*Cylindralithus* sp; Děvín, lateral view. **Fig. 20.** *Cylindralithus serratus* Bramlette & Martini; Děvín, lateral view. **Fig. 21.** *Stoverius biarcus* (Bukry) Perch-Nielsen; Děvín, sample K. **Figs. 22, 23.** *Reinhardtites anthophorus* (Deflandre) Perch-Nielsen; borehole Pavlov-5, 15.4 m. **Fig. 24.** *Reinhardtites* sp. cf. *R. levis* Prins & Sissingh; Děvín, sample K. **Figs. 25, 26.** *Microrhabdulus belgicus* Hay & Towe; Děvín, sample C. **Figs. 27, 28.** *Cretarhabdus* sp.; Děvín, sample C. **Figs. 29, 30.** *Acuturris scotus* (Risatti) Wind & Wise; borehole Pavlov-5, 57.8 m. **Fig. 31.** *Microrhabdulus decoratus* Deflandre; Mikulov 619. **Figs. 32, 33.** *Lucianorhabdus cayeuxii* Deflandre; borehole Pavlov-5, 41.0 m. **Fig. 34.** *Lucianorhabdus cayeuxii* Deflandre (curved form); Děvín, sample A. **Figs. 35, 36.** *Lucianorhabdus arcuatus* Forchheimer; Mikulov 619. Magnification 2,000×, photomicrographs by author.

Biscutum coronum Wind & Wise, high-latitude species (Wind 1979; Merlo 1984)

Arkhangelskiella cymbiformis Vekshina, high-latitude species (Wind 1979)

Micula decussata Vekshina, extremely abundant in higher latitudes (Wind 1979)

Biscutum dissimilis Wind & Wise, high-latitude species

Eiffellithus eximius (Stover) Perch-Nielsen, its last occurrence can be the key datum for low-latitude regions (Wind 1979)

Marthasterites furcatus (Deflandre) Deflandre, low- and mid-latitude species (Burnett 1990), only occasionally present in high north latitudes (Perch-Nielsen 1985)

Lithastrinus grillii Stradner, low- and mid-latitude species (Burnett 1990)

Reinhardtites levis Prins & Sissingh, more common in high north latitudes than in lower latitudes (Perch-Nielsen 1985)

Kamptnerius magnificus Deflandre, preferred cooler water temperatures (Thierstein 1976), high-latitude species (Wind 1979; Merlo 1994)

Biscutum magnum Wind & Wise, high-latitude species (Wind 1979; Merlo 1994)

Staurolithites mielnicensis (Górka) Perch-Nielsen

Dodekapodorhabdus noeliae Perch-Nielsen

Aspidolithus parcus (Stradner) Noel, its last occurrence may be used to define the upper boundary of Q. trifidum Zone in high latitudes (Martini in Wind 1979)

Monomarginatus pectinatus Wind & Wise, high-latitude species (Wind 1979; Merlo 1994)

Monomarginatus quaternarius Wind & Wise, high-latitude species (Wind 1979)

Acuturris scotus (Risatti) Wind & Wise, high-latitude species (Wind 1979)

Quadrum sissinghii Perch-Nielsen, low- and mid-latitude species (Wind 1979; Perch-Nielsen 1985; Burnett 1990)

Prediscosphaera stoveri (Perch-Nielsen) Shafik & Stradner, small forms of *Prediscosphaera* apparently prefer cooler waters and acmes are reported from the Maastrichtian of the austral realm (Pospichal & Wise 1992), high-latitude species (Merlo 1994)

Quadrum trifidum (Stradner) Prins & Perch-Nielsen, low- and mid-latitude species (Wind 1979; Perch-Nielsen 1985; Merlo 1994)

References

Abel O., 1899: Beziehungen des Klippengebietes zwischen Donau und Thaya zum alpin-karpatischen Gebirgssystem. *Verh. K.-kön. Geol. Reichsanst., (Wien)*, 5-6, 374-381.

Burnett J., 1990: A new nannofossil zonation scheme for the Boreal Campanian. *INA Newsletter, London*, 12, 67-70.

Crux J.A., 1982: Upper Cretaceous (Cenomanian to Campanian) calcareous nannofossils. In: Lord A.R. (Ed.): *A Stratigraphical Index of Calcareous Nannofossils. British Micropal. Soc.*, London, 81-135.

Deflandre G., 1959: Sur les nannofossiles calcaires et leur systématique. *Rev. Micropaléontol.*, 2, 127-152.

Merlo R.A., 1994: Nannofosiles del Cretacico de la Cordillera Betica (sur de Espana). Bioestratigrafia. *Thesis, Universidad de Granada, Facultad de Ciencias*, Granada, 1-413.

Mortimer C.P., 1987: Upper Cretaceous Calcareous Nannofossil Biostratigraphy of the Southern Norwegian and Danish North Sea Area. In: Stradner H. & Perch-Nielsen K. (Eds.): *INA, Vienna Meeting 1985, Proceedings. Abh. Geol. B.-A.*, Wien, 39, 143-175.

Perch-Nielsen K., 1985: Mesozoic calcareous nannofossils. In: Bolli H.M., Saunders J.B. & Perch-Nielsen K. (Eds.): *Plankton Stratigraphy. Cambridge Univ. Press*, Cambridge, 329-426.

Pospichal J. & Wise S.W.Jr., 1992: Southern high latitude K/T boundary calcareous nannofossils. *Memorie di Scienze Geologiche*, Padova, 43, 133-147.

Sissingh W., 1977: Biostratigraphy of Cretaceous nannoplankton, with appendix by Prins B. & Sissingh W. *Geol. en Mijnb.*, 56, 37-65.

Stráník Z., Bubík M., Čech S. & Švábenická L., in press: The Upper Cretaceous sediments in South Moravia. *Věst. Čes. geol. úst.*

Švábenická L., Stráník Z. & Bubík M., 1991: Turold quarry. In: Hamršmíd M. (Ed.): *Excursion guide, 4th INA conference Prague. Knihovnička ZPN*, 13, 75-83.

Švábenická L., 1992: Upper Cretaceous nannofossils from the Klement Formation (Flysch Belt of the Western Carpathians, Czechoslovakia). In: Hamršmíd B. & Young J. (Eds.): *Nannoplankton Research, Proceedings of the 4th INA Conference, Prague 1991. Knihovnička ZPN*, 14a, 189-205.

Thierstein H.R., 1976: Mesozoic calcareous nannoplankton biostratigraphy of marine sediments. *Marine Micropaleontology*, 1, 325-362.

Varol O., 1992: Taxonomic revision of the *Polycyclolithaceae* and its contribution to Cretaceous biostratigraphy. *Newsl. Stratigr.*, 27, 93-127.

Wagreich M., 1992a: Correlation of Late Cretaceous calcareous nannofossil zones with ammonite zones and planktonic Foraminifera: the Austrian Gosau section. *Cretaceous Research*, 13, 505-516.

Wagreich M., 1992b: A review of low-latitude "Tethyan" calcareous nannoplankton assemblages of the Cretaceous . *New Aspects on Tethyan Cretaceous Fossil Assemblages. Band 9 Schriftenreihe der Erdwissenschaftlichen Kommissionen der Österreichischen Akademie der Wissenschaften*, Wien, 45-55.

Wind F.H., 1975: *Tetralithus copulatus* Deflandre (*Coccolithophyceae*) from the Indian Ocean: A possible paleoecological indicator. *Antarct. J.U.S.*, 10, 265-268.

Wind F.H., 1979: Maastrichtian-Campanian nannofloral provinces of the Southern Atlantic and Indian Oceans. In: Talwani M., Hay W. et al. (Eds.): *Deep Drilling Results in the Atlantic ocean: Continental Margins and Paleoenvironment. Am. Geophys. Union*, 123-137.